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1992 Feature Article - Smarter Data Use

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Introduction

This article demonstrates that the short term seasonally adjusted movement of many important economic indicators is due substantially to short term irregular factors, and not the fundamental trend. Therefore it would be imprudent to place much reliance on such movements to predict the future trend of the indicator. It discusses how the irregular factors may reflect real short-term erratic effects as well as various statistical errors of measurement, and concludes that the smoothed seasonally adjusted (or trend) series is a more useful indicator of trend change for analysis and projection than seasonally adjusted series. Empirical measurements of the contribution of irregular factors are provided for several monthly and quarterly economic indicators.

The Australian Bureau of Statistics produces thousands of time series. Some of these series are referred to as “major economic indicators”, MEIs. Measures of unemployment, employment, building approvals, housing finance, gross domestic product and the balance of payments on current account are just some examples of MEIs. The release of MEIs is eagerly awaited by both government and private agencies, and the media give them prominence in reports. Analysts, commentators, forecasters, managers and governments are all interested in these time series because the MEIs can indicate where the economy has been and how it might develop in the future.

To monitor developments in MEIs, users frequently rely on various measures of change in the MEI’s behaviour. Unfortunately many of the commonly used procedures have notable deficiencies for estimating reliably the timing, level and shape of turning points in economic activity. Some examples of deficient procedures commonly used are discussed in the Feature Article : “**Picking Turning Points in the Economy**”, Australian Economic Indicators, April 1991.

In addition to using various procedures that are inherently deficient for monitoring turning points, many users apply those procedures to forms of the MEIs that contain highly irregular factors, ie. original or . seasonally adjusted series. The resultant measures of change can thus reflect mainly short-term erratic factors and not the fundamental trend of the activity of interest. A prime example is the monthly balance of payments on current account which is discussed in more detail below.

The consequences of using monitoring procedures that delay the detection of turning points and respond to irregular factors are increased when:

- MEIs become available some weeks or quarters after the period they refer to,
- further time is required to incorporate them into analyses and reports, and,

- the policy formulations and business decisions based on them may take months to implement.

The benefit of quickly and reliably identifying trend turning points is evident.

Time Series Components of MEIs

Many MEIs are released by the Australian Bureau of Statistics in three forms. These are:

- original series,
- seasonally adjusted series,
- smoothed seasonally adjusted, or “trend” series.

Each of these forms differs from the others in important respects, and these differences need to be understood so that effective use may be made of these particular indicators.

For many MEIs the movement in the original series can be due to a complex inter-action of up to six influences. Namely:

- seasonal influences,
- trading-day effects,
- moving-holiday impacts,
- other systematic calendar related effects,
- trend movements, and
- residual/irregular shocks.

When a series is seasonally adjusted, estimates of the seasonal influences, trading-day effects, moving-holiday impacts and the other systematic calendar related effects are removed from the original series. In some MEIs these effects can account for much of the period to period change in the original series, whilst for other MEIs they may make little contribution. For an indication of the relative importance of these effects refer to the Australian Economic Indicators Feature Articles “**Is the Consumer Price Index Series Seasonal?**”, February 1991 , and “**A Time Series Decomposition of Retail Trade**”, August 1991 . With the systematic calendar related effects removed from the original series, the movements in the seasonally adjusted series reflect the inter-action of only the trend behaviour and the residual/irregular shocks.

The residual/irregular shocks may reflect the real world phenomena that impact on economic activity in the short term. These influences can give rise to frequent chopping and changing of direction of both the original and seasonally adjusted MEIs.

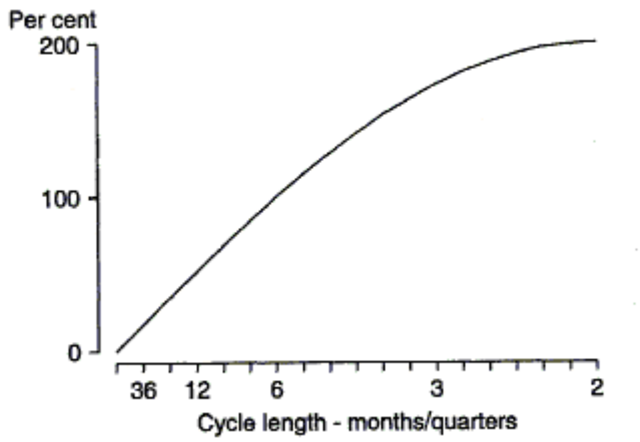
In addition to the real world irregular phenomena, the effects of statistical measurement errors need to be considered. For those MEIs derived from sample surveys there will be the impact of sampling error, that is, the variability that occurs by chance because a sample, rather than the entire population, is surveyed. There will also be non-sampling error associated with MEIs, regardless of whether they are derived from a sample survey or not. Non-sampling error represents the inaccuracies that may occur because of imperfections in reporting by respondents, errors made in collection such as in recording and coding of data, and errors made

in processing the data to its original and seasonally adjusted form. Errors of this type may occur in any enumeration, whether it be a full count or a sample.

The statistical measurement errors that do occur can impact on components other than the residual/irregular factors. For example an apparent seasonal or trading day pattern may be influenced by mis-reporting the timing of monthly activity, and the trend level may be affected by continual under-reporting. In practice it is not possible to quantify what proportion of the residual/irregular factor is attributable to the real world phenomenon or the statistical influences of sampling and non-sampling error that have flowed through to it. Nevertheless, it is possible to produce measures that indicate the relative contribution of the overall residual/irregular influences to the movement of the seasonally adjusted MEIs. As shown below, such measures indicate that for many important MEIs the short-term movements in seasonally adjusted series are.due mainly to residual/irregular factors and not the longer-term trend.

The above feature arises in part from the common practice of computing movements over spans of one period (month or quarter), usually using the seasonally adjusted data, or the original data when seasonally adjusted data does not exist. This practice (referred to as first differencing) as does differencing over longer time spans, alters the relative importance of the various cycles contained within the MEIs, as Graph 1 indicates.

GRAPH 1. EFFECT OF FIRST DIFFERENCING ON CYCLES
Per cent cycle strength remaining vs cycle length



The graph shows that first differencing will amplify the importance of the short term influences whose cycles correspond to the periods in the range of six to two months (quarters), magnifying them up to twice their initial importance. Influences whose cycles are longer than six months (quarters) are progressively sup-pressed. For instance, a business cycle of length three years would remain with about 20 per cent of its strength after first differencing the monthly data, while a short term cycle repeating every nine weeks has its importance nearly doubled.

It is evident from above that indicators that are volatile to start with, like many of the original and seasonally adjusted MEIs, will be more so after “differencing” to obtain various movement measures. Conversely, an indicator that contains little volatility relative to the medium to longer term signals will more clearly reflect trend movements even after being “differenced”. As indicated below, the **smoothed** seasonally adjusted MEIs serve that purpose better than the original or seasonally adjusted series.

Analysis of Short Term Movements

In the attachment, two indicators have been developed that measure the relative contribution of the volatile residual/irregular influences to the change, and percentage growth, of the seasonally adjusted series. The first indicator is named the **Relative Contribution of Residual/Irregularity to Growth, RCVG**, and this indicator accurately compares the residual/irregular component to the absolute growth of itself and that of the trend. The second measure is named the **Relative Contribution of Residual/Irregularity to Percentage Growth, RCR%G**, and it approximates a similar measure in percentage growth terms. It can be shown that the RCVG indicator approximates the RCR%G indicator in most applications, usually differing by only plus or minus a percentage point. The reader who wishes to calculate an RCVG (RCR%G) measure should refer to the attachment.

The tables below present the measure RCVG for a selection of MEIs, both monthly and quarterly, over the last decade, and the last five years. For comparison it also shows the average percentage movement (without regard to sign) of the seasonally adjusted series, AAG. This last measure gives the reader some indication as to how variable the seasonally adjusted series is from period to period. The RCVG measure is displayed in the tables so as to indicate how frequently, as a percentage of the period to period movements, it falls in a particular decile range; its median value is also given to indicate what value it exceeds fifty per cent of the time.

TABLE 1. RCVG FOR A SELECTION OF MEI'S OVER THE LAST FIVE YEARS

	Volatility Relative to Growth, RCVG (RCR%G), Last 5 years											
	AAG	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**	**Median**
MONTHLY MEI												
	%											%
Balance of Payments on Current Acct	29	0	0	2	7	3	7	7	15	27	33	84
Exports fob	4	2	2	0	8	10	10	8	12	30	18	76
Imports fob	5	3	0	0	6	3	8	17	13	23	27	80
Bldg App No. Total Dwg Units	4	3	10	7	8	3	12	18	12	18	8	64
Bldg App Value Non-Residential	21	0	2	5	8	0	2	7	15	13	48	89
Housing Finance No. Dwgs, All Lenders	6	7	3	5	5	10	12	12	13	13	20	68
New Motor Vehicle Reg	5	2	3	5	2	5	10	18	12	22	22	75
Retail Trade, Total	1	0	2	7	7	12	17	18	20	13	5	65
Unemployment Rate	3	5	5	8	5	5	25	10	18	15	3	58
Employed	0.4	7	2	10	12	20	15	13	10	5	7	49
QUARTERLY MEI												
GDP(I)	1	20	20	15	15	0	0	15	10	5	0	37
GDP(P)	0.9	20	5	5	0	15	15	20	15	0	5	53
GDP(P)	1	0	15	30	25	0	10	0	5	5	10	33
GDP(A)	0.8	10	15	20	10	15	10	15	0	0	5	35
GOS Private Corp Trade Ent	3	15	10	10	15	20	0	15	10	0	5	42
Company Profits	5	5	5	15	5	20	15	20	10	0	5	50
Private Gross Fixed Capex	4	25	15	20	20	20	0	0	0	0	0	26
Bldg Activity Comm.	9	5	5	10	20	15	10	5	10	0	20	48

TABLE 2. RCVG FOR A SELECTION OF MEI'S OVER THE LAST TEN YEARS

	Volatility Relative to Growth, RCVG (RCR%G), Last 10 years											
	AAG	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**	**Median**

MONTHLY MEI												
	%											%
Balance of Payments on Current Acct	27	2	1	3	4	3	7	7	17	25	33	83
Exports fob	6	2	2	1	6	8	10	10	13	24	24	78
Importsfob	6	2	3	3	4	7	8	13	12	23	23	78
Bldg App No. Total Dwg Units	4	3	8	3	5	8	13	16	16	18	10	66
Bldg App Value Non-Residential	20	1	1	5	6	0	2	8	18	20	39	87
Housing Finance No. Dwgs, All Lenders	5	7	5	8	7	9	14	10	11	15	15	60
New Motor Vehicle Reg	5	2	2	5	2	5	12	16	11	23	23	75
Retail Trade, Total	1	4	8	8	12	12	15	16	13	9	2	53
Unemployment Rate	3	4	6	7	7	9	24	8	16	12	7	52
Employed	0.4	7	4	9	10	17	17	16	10	6	5	52
QUARTERLY MEI												
GDP(I)	1	10	15	22	20	2	0	15	10	2	2	31
GDP(E)	1.0	25	8	10	7	8	17	15	18	0	2	51
GDP(P)	1.2	7	18	38	15	0	5	3	2	2	10	25
GDP(A)	0.9	12	20	18	10	12	10	10	2	3	2	31
GOS Private Corp Trade Ent	5	8	12	12	15	10	2	12	15	2	10	44
Company Profits	5	10	3	16	13	16	13	13	6	0	10	47
Private Gross Fixed Capex	4	22	12	12	20	18	8	5	0	0	2	32
Building Activity Comm.	8	2	5	10	22	10	12	10	8	8	12	51

It can be seen in Tables 1 and 2 that the RCVG (and RCR%G) of the monthly MEIs tends to be dispersed more in the higher decile regions than the quarterly MEIs. This is to be expected when monthly figures are accumulated to form a quarterly series, because the monthly chopping and changing of direction of the residual/irregular influences tend to cancel out over the three months of the quarter, while the smoother trend behaviour generally builds on itself month by month. This tendency can be clearly seen in Table 3 where the monthly and quarterly measures of some balance of payments MEIs are compared.

TABLE 3. RCVG FOR A SELECTION OF BALANCE OF PAYMENTS MEI'S OVER THE LAST FIVE YEARS

	Volatility Relative to Growth, RCVG (RCR%G), Last 5 years											
MEI	**AAG**	**0-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**80-90**	**90-100**	**Median**
Balance of Payments on Current Acct	%											%
Monthly	29	0	0	2	7	3	7	7	15	27	33	84
Quarterly	10	10	5	5	10	0	25	15	25	0	5	55
Exports fob												
Monthly	4	2	2	0	8	10	10	8	12	30	18	76
Quarterly	4	0	0	0	20	35	15	10	10	5	5	48
Imports fob												
Monthly	5	3	0	0	5	3	8	17	13	23	27	80
Quarterly	4	10	5	0	10	15	5	5	20	10	20	68

While the above discussion illustrates that seasonally adjusted quarterly indicators tend to be less volatile than their corresponding monthly series, it should not be assumed that **quarterly**

series are necessarily better indicators of trend behaviour than the **monthly series**. Monthly trend estimates will generally disclose, in a more timely fashion than their quarterly counterpart, the presence of peaks and troughs, points of inflexion (both stationary and non-stationary), plateaus and slopes (both up and down). This is one of the reasons many MEIs are compiled monthly and not quarterly. But it is **the smoothed seasonally adjusted monthly series (ie. the trend series) that should be used as the trend indicator, not the monthly seasonally adjusted series from which it is derived**.

Where the seasonally adjusted quarterly MEI's are used, it should be noted that their quarter to quarter movements may also be driven by substantial degrees of irregularity, although generally not to the same extent as the monthly MEI's. For example, Table 1 indicates that for half the time the volatile irregular factors of the various measures of constant price gross domestic product (GDP(I), GDP(E), GDP(P) AND GDP(A)) account for more than one third of the seasonally adjusted gross movement (and percentage growth). For company profits and building commencements, the irregular contribution to change is greater than about 50 per cent for half the time. Again, when smoothed seasonally adjusted estimates are available, they are the most reliable indicator of underlying trend.

Concentrating on the RCVG measures for the monthly MEIs over the last five years (Table 1) it can be seen how erratic some of the seasonally adjusted growth measures have been. Consider the topical monthly balance of payments On current account. The median RCVG value is 84 per cent. This indicates that in thirty of the last sixty monthly movements the volatile irregular factors have accounted for over 84 per cent of the seasonally adjusted gross movement, and percentage growth. Table 1 also shows for this series that RCVG is less than 50 per cent only twelve per cent of the time. That is, the trend has contributed more than the residual/irregular factors have to the variability of the seasonally adjusted series in only seven of the last sixty movements.

For this series the empirical evidence clearly indicates that the seasonally adjusted movements rarely are attributable to fundamental trend changes. The data does indicate, however, that the seasonally adjusted monthly balance of payments on current account is generally driven by real world volatile shocks on the domestic and international economy, and various statistical errors of measurement. Predicting whether this seasonally adjusted series will rise or fall is very much like tossing a coin. Those who report, comment on, analyse, and make policy and commercial decisions on the basis of these volatile seasonally adjusted movements, should remember that the movements rarely reflect trend changes of substance.

By comparing the results contained in Table 1 with those in Table 2 an assessment can be made of whether a particular series is becoming more irregular. For instance, it can be seen that for seasonally adjusted, constant price gross domestic product(income based), GDP(I), the median RCVG is 37 for the last 5 years and 31 for the last 10 years. An even greater difference can be seen for seasonally adjusted monthly retail trade (65 versus 53). The increased contribution of the irregularity to these series movements may be attributable to increasing economic volatility in the real world, improving measurement of a stable degree of real world irregularity, or increasing degrees of statistical errors. This last factor is prone to occur at the current end of the seasonally adjusted series because of the nature of the seasonal adjustment methodology. Regardless of the causes of the irregularity, it should be noted that contemporary MEI movements can be more irregular than historic ones.

Consider now some of the monthly MEIs commonly used as partial leading indicators of economic performance. From Table 1 it can be seen that for housing finance, number of dwellings, all lenders, irregular factors have accounted for over 68 per cent of the seasonally adjusted gross movement (and percent-age growth) in thirty of the last sixty movements. The irregular factor's contribution has been less than the trend's (that is, the RCVG is less than 50 per cent) in only 30 per cent of the monthly seasonally adjusted movements. For building approvals, number of total dwelling units, irregular factors have accounted for over 64 per cent of the

seasonally adjusted gross movement (and percentage growth) in thirty of the last sixty movements. The irregular factor's contribution has been less than the trend's in 31 per cent of the monthly seasonally adjusted movements. For new motor vehicle registrations, irregular factors have accounted for over 75 per cent of the seasonally adjusted gross movement (and percentage growth)in thirty of the last sixty movements. The irregular factor's contribution has been less than the trend's in 17 per cent of the monthly seasonally adjusted movements.

Conclusion

The tables above illustrate that a substantial proportion of the seasonally adjusted change, and percentage growth, of commonly used MEIs is attributable to volatile short-term factors, and not to the trend behaviour. Given that this conclusion applies to many seasonally adjusted MEIs, and other indicators as well (be they from ABS or elsewhere), users of them should carefully assess whether such seasonally adjusted indicators are fulfilling the analytic function required or expected of them.

If the user wishes to analyse and monitor the trend of an activity, then the smoothed seasonally adjusted (or trend) series should be used. As discussed above, these indicators reflect the medium to longer term influences associated with trend behaviour. On the other hand **the seasonally adjusted series contains the full impact of all the short term volatile factors, as well as the trend**. As discussed above, the short term volatile factors arise because of real world irregular events and various degrees of statistical measurement error, of a sampling and non-sampling nature. The tables above illustrate that many of the high profile seasonally adjusted MEIs that are reported on by the media, and which are used in decision making by various government, public and private agencies, are changing from period to period primarily because of the volatile factors discussed above.

If there is thought to be a valid need to focus on and respond to these short term volatile factors, users will be more appropriately informed by directly analysing the departure of the seasonally adjusted series from the trend series, and the possible reasons for this departure. A study of such a measure over the longer term will show that it generally behaves like a random variable.

This feature article was contributed by John Zarb, Time Series Analysis, ABS.

ATTACHMENT

Relative Contribution to Movements

The trend estimates released by the Australian Bureau of Statistics are produced by smoothing out the residual/ irregular component of the seasonally adjusted series, using a statistical procedure discussed in Information Paper cat. no. 1316.0 : **A Guide to Smoothing Time Series - Estimates of Trends**. The procedure is designed to minimise distortion to trend level, turning point shape and timing, and is based on Henderson moving averages. Generally a 13 term Henderson moving average is applied to monthly series, and a 7 term to quarterly series.

As a result of this approach to smoothing the seasonally adjusted series, the monthly trend estimates will contain the full effect of all cyclical components two or more years in length, and diminishing amounts of cyclical components in the range two years to a half year (refer to Graph 10 of cat. no. 1316.0). The short term cycles in the range of a half year to two months length are generally eliminated from the 13 term Henderson based trend estimate. A measure of the volatile residual/irregular component, V, may be obtained as the difference between this trend estimate, T, and the seasonally adjusted series, A,

Equation 1

V = A - T

It follows from the above discussion that this measure of the volatile residual/irregular component may contain for the monthly case all the influences of the very short term non-seasonal cycles whose period lies in the range of two months to a half year, and to a diminishing degree the influence of the non-seasonal cycles in the range of a half year to two years in length.

In the case of quarterly data the use of a 7 term Henderson moving average produces trend estimates that may contain the full effect of all cyclical components longer than four and a half years, and diminishing amounts of cyclical components in the range of four and a half years to about three quarters of a year (refer to Graph 13 of cat. no. 1316.0). A two year cycle would remain with about 90 per cent of its initial strength. The very short term cycles are generally eliminated from the 7 term Henderson trend estimates. The residual/irregular component of Equation 1 therefore contains all the influences of the very short term cycles whose period lies in the range of two quarters to three quarters, and to a diminishing degree the influence of the non-seasonal cycles in the range of three quarters to four and a half years.

In practice what cycles are actually found in the trend, T, and volatile residual/irregular component, V, depends on what cycles exist in the original data. Each MEI will have its own characteristic mixture of various long, medium and short term cycles, as well as its own seasonal patterns.

From Equation 1 it is evident that the change in the seasonally adjusted series, A, is equal to the change in the trend, T, and the change in the volatile residual/irregular influences, V.

Equation 2

$$\Delta A = \Delta V + \Delta T$$

To determine the relative contribution that the short-term volatile residual/irregular influences, change in V, have to the seasonally adjusted change, change in A, compared to that of the trend, change in T, the measure represented by Equation 3 might be considered:

Equation 3

$$\frac{\Delta V}{\Delta V + \Delta T}$$

However, because change in V and change in T may take on positive and negative values the Equation 3 measure may be difficult to interpret. For example, consider change in V = -2 and change in T = +4

$$\frac{\Delta V}{\Delta V + \Delta T} = \frac{-2}{-2 + 4} = -100\%$$

The result of -100 per cent may imply that the volatile residual/irregular influences, change in V, have contributed **100 per cent to a decline** in the seasonally adjusted series, change in A, which was not the case in this instance.

In this example the seasonally adjusted series grew 4 units in a positive direction because of the

trend, then a further 2 units in the negative direction because of the volatile residual factors. In all the gross or absolute movement of the trend and short term residual/irregular factors was 6 units, but each movement was such that the net growth was +2 units. A meaningful measure of relative contribution is obtained by considering the component changes without regard to their sign, as in Equation 4.

Equation 4

$$\frac{|\Delta I|}{|\Delta I| \; + \; |\Delta T|}$$

In the example above Equation 4 gives

$$\frac{|-2|}{|-2| \; + \; |4|} = \frac{2}{6} = \frac{1}{3}$$

That is, the volatile residual/irregular influences in this example account for a third of the gross movement of the seasonally adjusted series. The measure described in Equation 4 will be referred to as the **Relative Contribution of Residual/Irregularity to Growth, RCVG**, and hereafter will be expressed as a percentage.

Above the relative contribution of a component to an actual change has been considered. Below a measure is developed for the relative contribution to a percentage growth. At any point in time it is possible to regard the seasonally adjusted series as being composed of the trend estimate multiplied by an index number, R, that represents the residual/irregular shocks.

Equation 5

A = T x R

When there are no net residual/irregular influences operating R=1 .0, and A = T. If R = 1.10 the seasonally adjusted series would contain a residual/irregular effect that lifts the seasonally adjusted series ten per cent above the trend; R = 0.95 indicates a residual/irregular effect that takes the seasonally adjusted series five per cent below the trend. Given Equation 5, it can be shown that the percentage change of the seasonally adjusted series, is equal to the sum of the percentage change of the trend, the percentage change of the residual/irregular shocks, and one hundredth of the product, percentage change in T x percentage change in R, as in Equation 6.

Equation 6

$$\%\Delta A = \%\Delta T + \%\Delta R + \frac{\%\Delta T \; + \; \%\Delta R}{100}$$

The product term $\frac{\%\Delta T \; + \; \%\Delta R}{100}$

will generally be small, so the percentage growth of the seasonally adjusted series will be approximated closely by the sum of the percentage growths of the trend, T, and residual/ irregular shocks, R, as in Equation 7.

Equation 7

$$\%\Delta A \approx \%\Delta T + \%\Delta R$$

Equation 7, is analogous to Equation 2, and the percentage growth of the trend and the residual/ irregular influences can also be either positive or negative. Using similar reasoning to that above, a meaningful measure of the relative contribution of the residual/irregular shocks to the percentage growth of the seasonally adjusted series is given by Equation 8.

Equation 8

$$\frac{|\%\Delta R|}{|\%\Delta T| + |\%\Delta R|}$$

The measure described by Equation 8 will be referred to as the **Relative Contribution of Residual/Irregularity to Percentage Growth, RCR%G**, and hereafter will be expressed as a percentage.

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